The fifth in a series of reports on electrical/electronic connectors

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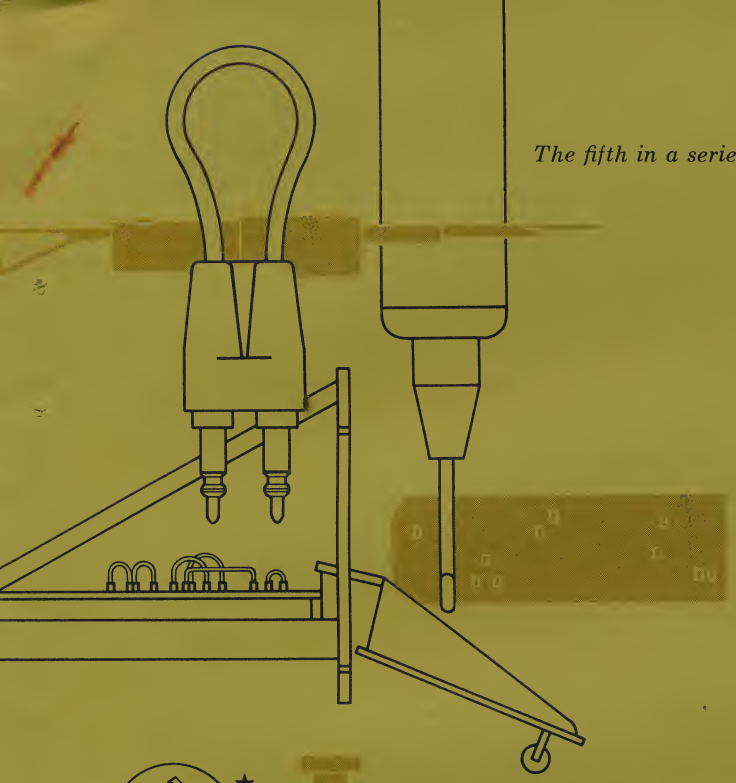


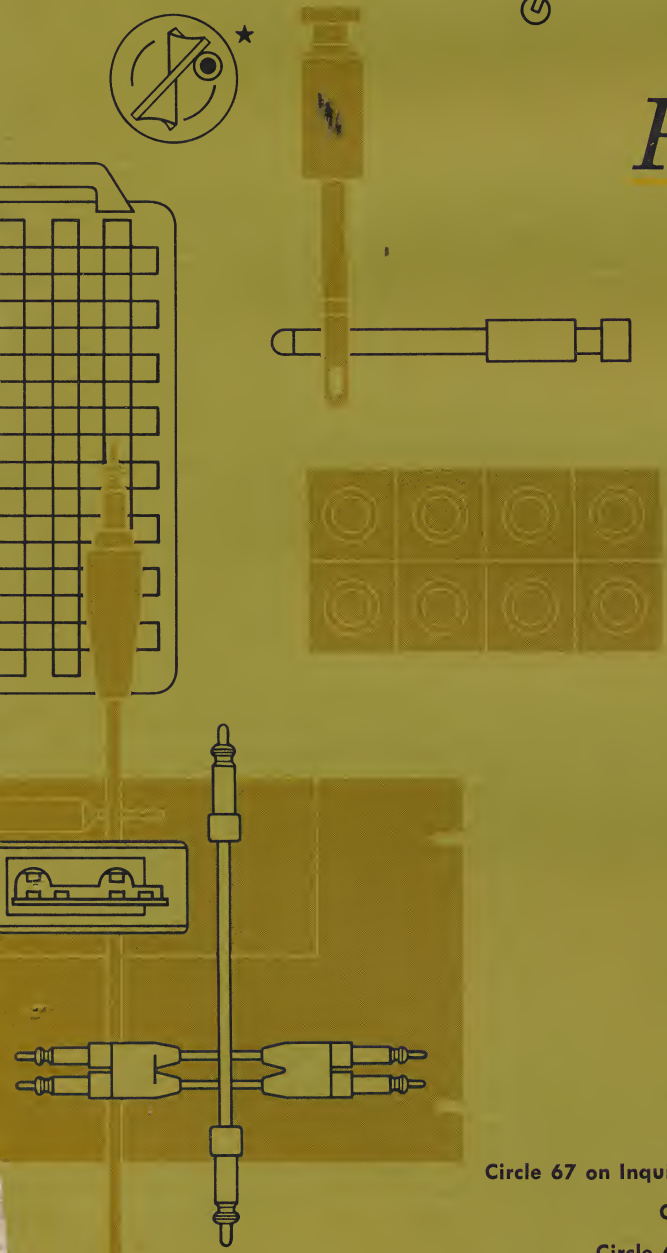
Special Report From AMP On PROGRAMMING DEVICES

Programming devices defined and explained

How programming devices function in switching applications

AMP is the one complete source of programming devices

Design factors contributing to the reliability of programming systems



In this modern age of electronic control and data acquisition, the ability to make and change circuit connections quickly and easily is becoming increasingly important.

In the following pages we have attempted to define a number of industrial, commercial and military uses for programming systems and to show how AMP has developed a complete line of such devices to help solve the ever-growing complexity of switching applications.

Circle 67 on Inquiry Card for information on Universal Patchcord Programming Systems

Circle 68 on Inquiry Card for information on Card Programming System

Circle 69 on Inquiry Card for information on Pinboard Programming Systems

Circle 70 on Inquiry Card for information on Coaxial & Shielded Patchcord Programming Systems

PROGRAMMING DEVICES DEFINED AND EXPLAINED

Any change in the function of electrically controlled equipment necessitates a change in the electrical/electronic circuitry for that equipment. This change can be effected in many ways, ranging from the simple flip of a switch to major rewiring of the equipment, depending on the complexity of the system. Whatever the method, however, re-routing of circuit paths almost always involves an electromechanical change.

Basically, programming devices are manually operated switches that permit, through proper patchcord, pin or contact selection, nearly infinite switching combinations. Such devices may be used as simple or complex switches, or as large connectors interconnecting a main body of equipment to peripheral components.

SIMPLIFIED SWITCHING

Simplified switching is normally defined by the number of poles and throw positions required by a particular switching application. The following illustrates the use of A-MP★ SYSCOM★ patchcord programming systems in simple switching:

SWITCH TYPE	AMP SYSTEM SIZE	NO. FRONT BOARDS
816-pole single-throw	1632 Contacts	1
544-pole double-throw	1632 Contacts	2
408-pole triple-throw	1632 Contacts	3
816-pole triple-throw	3264 Contacts	3

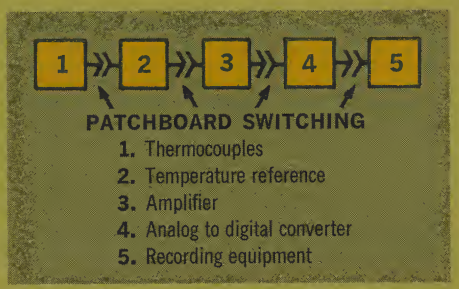
Combinations of the above systems may be used and still be considered examples of simplified switching.

Patchcord programming systems can be used as large connectors. This function is particularly useful in interconnecting various sections of equipment. When using this system as a connector the rear bay is used as one half and the front board as the other half of the connector. Programming systems offer two distinct advantages over conventional multiple connectors:

1. Large number of contacts. Systems are available with 240 through 5304 contacts, as compared with connectors whose contact force and tolerance buildups restrict capacity.
2. Long contact life. Programming systems are designed for thousands of insertions and withdrawals, whereas pin and socket connectors need be designed for only 500 to satisfy military specifications.

COMPLEX SWITCHING

Programming devices are used quite often in electronic equipment that requires the patching of one signal many times on one front board. An example of this is in data acquisition systems where the signal is carried from transducers (strain gauges, accelerometers) to signal conditioning equipment (voltage and temperature references, amplifiers, etc.) to analog-to-digital converters to recording equipment. Following is a simplified block diagram of multiple-use signal flow:



Where one signal is patched many times, variable contact resistance can degrade it beyond usability. Chance of signal loss is also greater when many patches are used. In complex switching applications, therefore, consistently low contact resistance and reliability are critical, regardless of the type of programming device employed.

HOW PROGRAMMING DEVICES FUNCTION IN SWITCHING APPLICATIONS

In the programming of circuits for multi-use equipment, such as rolling mills, control systems, automatic test equipment, ground support equipment or teaching devices, circuit paths must be established in the shortest possible time to minimize labor and downtime costs. Consequently, the need for quick, reliable, flexible switching devices is critical in these applications.

The baking industry is a case in point. Mixing a batch of cookie or cracker dough means blending tons of various dry and liquid ingredients several times a day. In such large scale operations a computer usually controls the actual production. But the inputs determining a specific blend of ingredients originate from a card programming system which routes hundreds of pre-programmed circuits.

Consider the switching problems faced by engineers in the modernization of a multiple cell rocket propulsion laboratory that includes many pieces of control, calibration, recording, detection and data analyzing equipment—all of which had to be made available to every test cell and monitored in a master control room. The downtime required to set up the necessary interconnections for each test program would have consumed several days, had not programming systems with pre-programmable patchboards been installed throughout the test facilities.

To cite just one more example, this time in the medical field, a large metropolitan hospital designed and built a machine to simulate physiological conditions such as blood pressure, temperature and respiratory data for recognition by interns and resident physicians. The complexity of this machine required a semi-automatic method for setting up the specific pathological inputs. The problem was solved by installing a card programming system, using punch cards, each of which contained encoded information representing a given disease.

Thus, we see that uses for programming devices are as broad as there are equipment applications for them. The range is, in fact, almost infinite, encompassing relatively simple applications like programming function generators for a design engineer to sophisticated data acquisition programs requiring thousands of switching operations. To meet these specialized needs, four basic types of programming devices have been created. All are represented in AMP's Programming Devices product line.

TYPES OF PROGRAMMING DEVICES AVAILABLE

Although all programming devices perform the function of a large switch, mechanically they may be grouped into three categories: *patchcord systems*—universal, coaxial and shielded types—with fixed or removable front boards; *card systems* with tabular punch cards as the medium of control; and *pinboard systems*—Matrix and Universal types—with pins as the medium of control.

AMP IS THE ONE COMPLETE SOURCE OF PROGRAMMING DEVICES

The growing use of programming systems in such diverse fields as automation on the assembly line, mixing processes in the food and chemical industries, and military and commercial data processing and analysis has directed our concentrated research and development toward the creation of an entire line of programming products, manual to completely automated devices. These are designed to cover every possible area and meet the most complex circuit switching requirements.

PROGRAMMING SYSTEMS

Of all these devices, the various A-MP Patchcord Programming Systems have the most varied and complex uses. These are subdivided into the following classifications: I. Universal Systems (a) Panel Mount; (b) Rack Mount; (c) Anti-Vibration; (d) Airborne; and (e) Fixed Panels. II. Coaxial Systems (a) Panel Mount; and (b) Fixed Panels. III. Shielded Systems (a) Panel Mount; and (b) Fixed Panels.

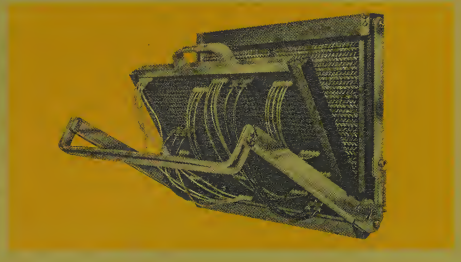
Other A-MP Programming Devices are: IV. Card Programming Systems (a) Desk Top; and (b) Rack Mount. V. Pinboard Programming Systems (a) Matrix; and (b) Universal.

I. UNIVERSAL SYSTEMS

A-MP Universal Patchcord Systems and Panels are designed for low and medium frequency switching applications. Because of the many different applications, for which these are used, there cannot be a definite line of demarcation in choice of systems.

The systems all have an over center camming action combined with "zero entry" patchboards. The camming provides the AMP patented double wiping action which assures clean, reliable and minimum contact resistance between the patchcords and contact springs. The "zero entry" eliminates the possibility of contact damage when the patchboard is engaged.

a. Panel Mount Systems.



These systems are designed, in a number of sizes, for vertical mounting on the

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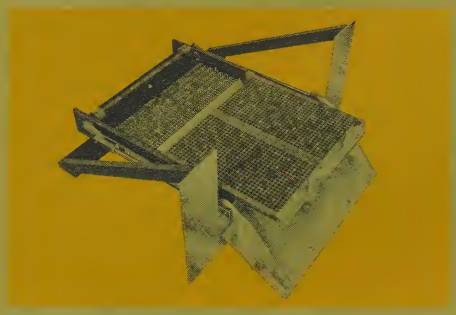
face of racks or panels. They range in size from 240 to 5304 contacts. Other sizes can be furnished to meet customer requirements.

Panel Mount Systems are highly versatile in their programming performance and permit rapid interchange of circuits with assurance of complete reliability.

b. Rack Mount Systems.



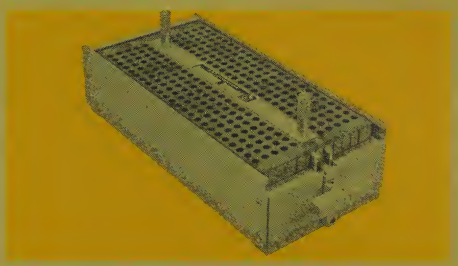
The A-MP Rack Mount Systems have the same performance characteristics and programming versatility as the panel mount type. However, they are mounted horizontally within a cabinet, console, or desk, and require up to 50% less panel area than vertically mounted systems. The specially designed frame and actuating mechanism permit easy access for rapid programming changes.

The four standard sizes ranging in size from 680 to 1632 contacts require only 8¾″ of rack height and fit any standard 19″ wide E. I. A. rack. These systems are rigidly contructed for maximum durability and are easily integrated with equipment styling. An optional drawer slide permits "post patching" (individual patchcord change) without circuit interruptions to any program.

c. Anti-Vibration Systems.

The two Universal Anti-Vibration Systems (806 and 1280 contacts, respectively) are designed to withstand the highest extremes of vibration and shock. All frames and other protective components are made of stainless steel with the exception of an aluminum dust cover for the smaller system.

d. Airborne Systems.



Utilizing 240 and 408 contacts, these programming systems are light and compact, and are designed for high resistance to shock, vibration and other severe environmental conditions.

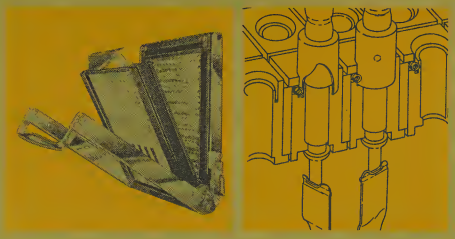
e. Fixed Panels.

Fixed programming panels in eight sizes with 120 to 4896 contacts meet a large variety of programming needs. These panels have non-removable patchboards and are designed for infrequent changes in programming. Except for the non-interchangeability of patchboards, A-MP Fixed Panels serve needs comparable to those of the programming systems.

II. COAXIAL PROGRAMMING SYSTEM

Coaxial Programming Systems and fixed panels are designed for high frequency, low level applications where each input must be individually shielded. These systems use coaxial contacts and patchcords to maintain low cross-talk and VSWR and permit, for the first time, the change of thousands of individual coaxial connections at one time. Hybrid systems and panels containing both universal and coaxial contacts are available. (The Standard sizes range from 506 to 3036 contacts.) The system's actuating mechanism is slightly different from the universal and shielded systems in that it provides parallel entry of the patchboard before the camming action. Redundant contacts, coupled with AMP's exclusive double wiping action, assures clean, reliable and low-resistance contact between patchcord tip and rearboard spring. The contact design also allows patching after the system has been engaged, so that all of the connections do not have to be broken in order to make minor changes in programming.

III. SHIELDED PROGRAMMING SYSTEMS



Shielded Programming Systems and Panels, with 112 to 3600 contacts, are for medium and high frequency low-level applications. Programming boards, as well as rear frame spring assemblies, are fully insulated and shielded. This reduces cross-talk and effectively restricts outside interference.

Both the programming boards and rear boards have individual nylon cells spaced ⅜″ on centers and are surrounded by interlocking shields. This arrangement provides an effective ground barrier around each patchcord tip and contact spring.

The standard patchcord for shielded systems and panels is made of sub-miniature coaxial cable. The shields of all patchcords within a patchboard are commoned to the interlocking shield of the board.

Similar to the universal type, both patchboard systems and fixed panels are available.

IV. CARD PROGRAMMING SYSTEM

The A-MP Card Programming System consists of 960 single-pole, single-throw switches which are actuated by a single operating lever and controlled by tabulating cards. It translates the punched information on each card into electrical outputs which control the equipment involved. The use of pre-punched tabulating cards simplifies equipment programming and reduces the chance of operator error. These systems may be used for data readout, as well as programming of multi-use equipment.

These systems are available in rack-mount or desk-top types. Both contain long-life gold over nickel plating of contact springs and pads and both provide optimum reliability through the use of AMP's double-wiping action. Interlocks prevent false output. A semi-automatic card ejector simplifies operation by partially ejecting the card when the operating lever is brought to "load" position.

V. PINBOARD PROGRAMMING SYSTEMS

The two types of pinboard programming systems—Matrix and Universal—combine to complement both the patchcord programming systems and the card programming systems. They both have simplicity, flexibility and economy. In both, circuit switching is done with a simple pin.

The matrix pinboard lends itself to such applications as semi-fixed digital memories, control of sequencing devices, automated process control and test equipment programming. The universal pinboard is used

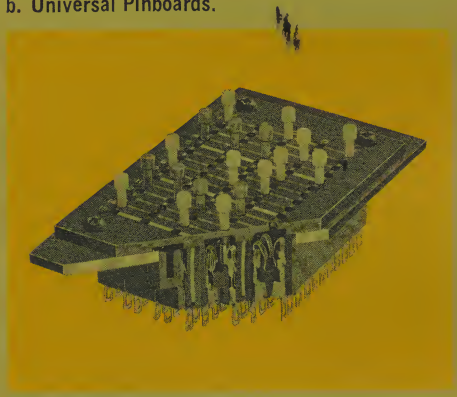
for specialized programming and more complex switching functions.

a. Matrix Pinboards.

The matrix pinboard is made of two bus type contact strips arranged on X and Y coordinates. These strips are connected by either shorting or diode pins. By connecting inputs to the horizontal strips and outputs to the vertical contact strips, it is possible to connect any input to any output. It is also possible to connect all inputs to the one output or all outputs and inputs together.

Programming templates are available for simplification of programming.

b. Universal Pinboards.



This type of pinboard consists of a specified number of single-pole, single-throw normally open switches each of which operates independently of the others. It is ideally suited for highly specialized programming or switching which is beyond the capabilities of the Matrix Pinboard. A good example is digital programming of the inputs of an analog computer.

In the Universal Pinboard, circuit-commoning functions are readily accomplished through the use of appropriate, permanent wiring installed on the rear of the board by the user. Contact springs of phosphor bronze, plated with gold over nickel, can be interconnected in any desired configuration. Panels can be made with as many matrices as may be required in a wide variety of sizes. Standard size boards range from a 15 x 5—75-hole type to a 15 x 40—600 type.

RELIABILITY IN PROGRAMMING SYSTEMS

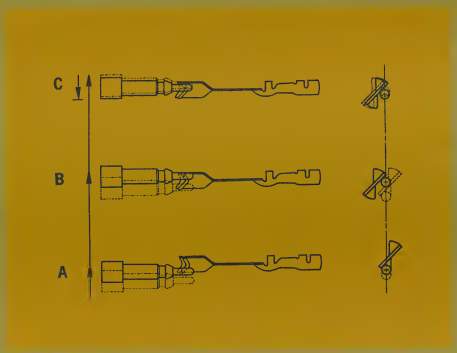
Because of the magnitude of the circuitry handled by programming devices and the rugged environments in which many of them operate, reliability is a vital concern to the systems designer who must select them. In a single line-to-line pin and socket connector, electrical performance of the assembled unit is determined by the sum of the mechanical properties of the contacts. Multiply these properties by the hundreds of connections routed by a single patchboard system, for example, and you will begin to appreciate the important role that reliability plays in any programming device.

Through proper choice of materials, superior design of the various elements and insistence on close quality control in every step of the manufacturing procedure, a high degree of reliability is achieved. Factors which contribute to the reliability of A-MP programming products are:

DOUBLE-WIPING CONTACT ACTION

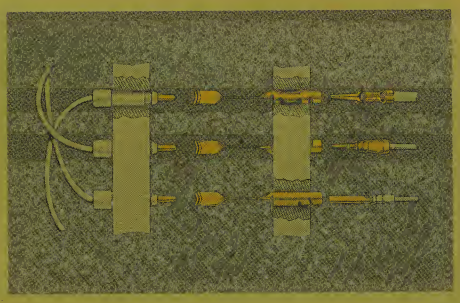
Since the majority of programming systems operate on low level or "dry" circuits, the areas of electrical contact must be absolutely free from contamination by oxides or dust. In all A-MP Patchboard Systems and Panels and Card Programming Systems gold over nickel plating eliminates oxide contamination. AMP's patented double-wiping action of the contacts assures that the mating surfaces will be pre-cleaned.

In the removable front board of A-MP Patchboard Systems, the operating mechanism of the system causes the patchcord pins to wipe the mating chevron springs as shown in the illustration below. The patchcord pin travels the length of the chevron to a point of maximum travel, then recedes to its previously wiped operating position. This action completely removes lint, dust and other contaminants from the contact areas to assure positive contact.



The same reliability feature has been designed into the A-MP Card Programming Systems to insure positive sensing. In this case, the spring loaded stop block causes the card tray to return a fraction of an inch so that the spring contacts rest on a pre-cleaned portion of the contact pads.

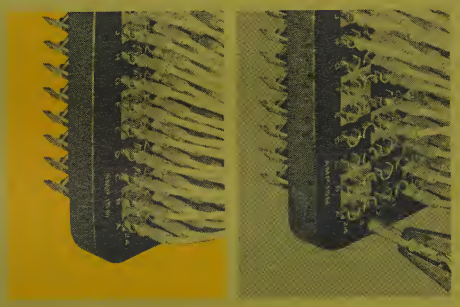
GOLD OVER NICKEL PLATING



The overall reliability of any electrical system depends on the mechanical integrity of its various connections. In all critical circuits, minimal contact resistance is essential. Gold is universally recognized as the best plating element because of its exceptionally high conductivity and corrosion resistance. The average contact resistance between a gold plated patchcord pin and contact spring is .002 ohms. This value is stable down to low microvolt levels. AMP plating investigations show that copper oxides will migrate through gold. As a barrier against such migration, a nickel sub-plating is used as standard. Gold over nickel plating, checked to a tolerance of a millionth of an inch by an exclusive AMP X-ray technique, is used for all A-MP contact springs.

POSITIVE REAR-BOARD WIRING

In the interface between programming systems and the electronic equipment they control, serviceability, minimum contact resistance and reliability are essential. Depending on individual requirements, the user has a choice of two A-MP products: The LANCELOK★ terminal or AMP's "53" Series Taper Pin. Both wiring devices provide simplified insertion and removal, low millivolt drop and maximum dependability.



The materials and design of the LANCELOK Terminal and spring receptacle provide multiple contact areas which result in low contact resistance. An integral spring lock provides a minimum of 20 pounds retention between the terminal and contact spring. These devices are especially effective in programming systems that are subjected to severe vibration and shock.

The A-MP "53" Series Taper Pins permit high, uniform retention and excellent electrical stability. These terminals are well suited to both critical and non-critical wiring applications, and—like the LANCELOK Terminal — are available either pre-insulated on non-insulated.

Gold over nickel plating in critical circuits, rear-board wiring flexibility, double-wiping contact action, and the choice of quality construction materials previously discussed, are just part of the AMP reliability story. Other factors, such as application tooling designed to match the terminals, simplicity of design to minimize the number of parts, and AMP's superior crimping technique must also be mentioned as contributing to the high reliability standards of A-MP Programming Systems.

In this report we have outlined some of the more distinctive and exclusive features of A-MP Programming devices. These features have evolved from intensive, continuous research based on sound fundamentals, to meet the new, more varied and, in most cases, more complex programming needs.

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